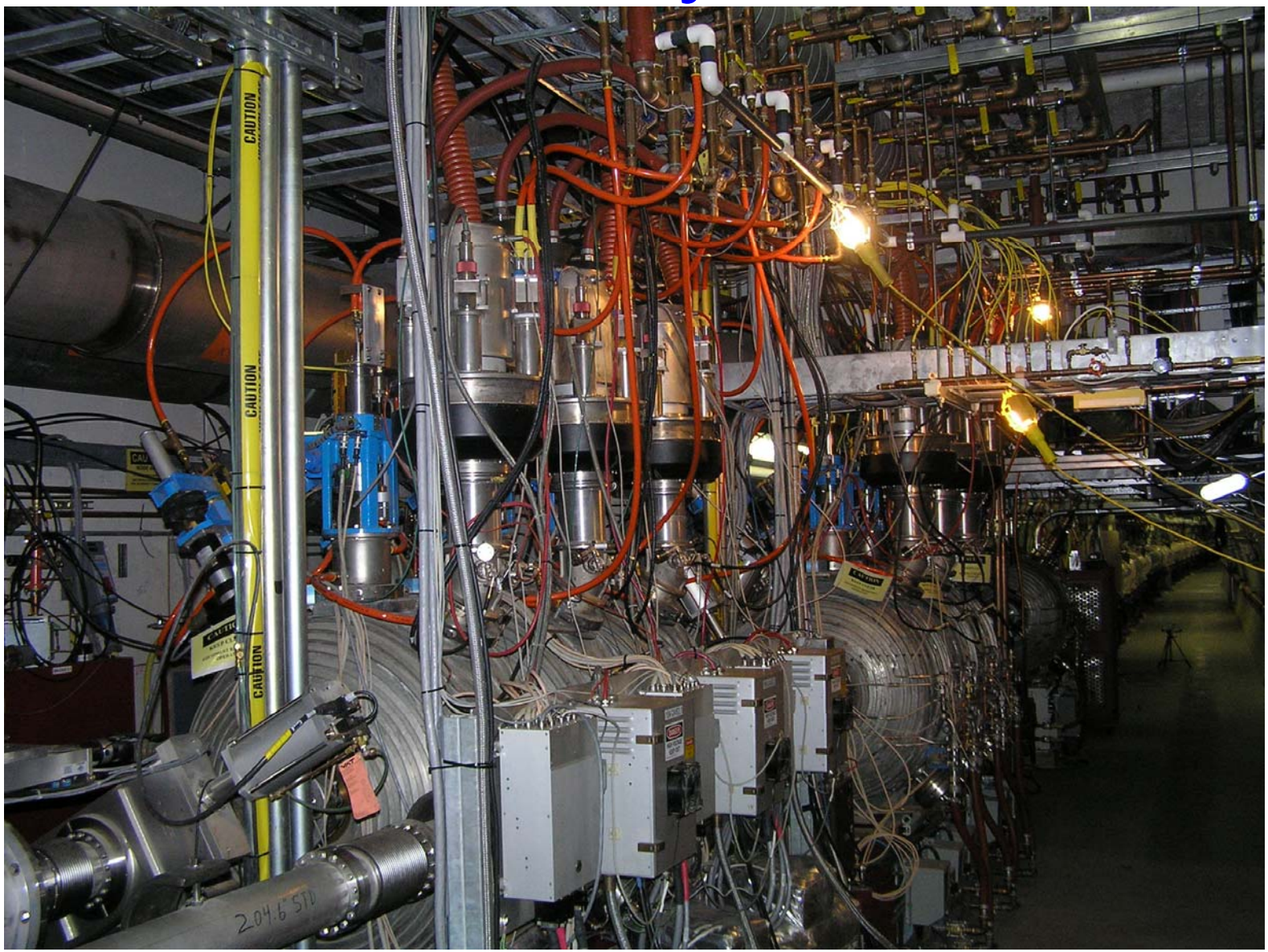
RF System Report
FY05 Retreat

Topics

- Safety Improvements
- Acceleration cavities' tuners
- Storage cavity window R&D
- Ring-to-ring synchro at transition

Safety

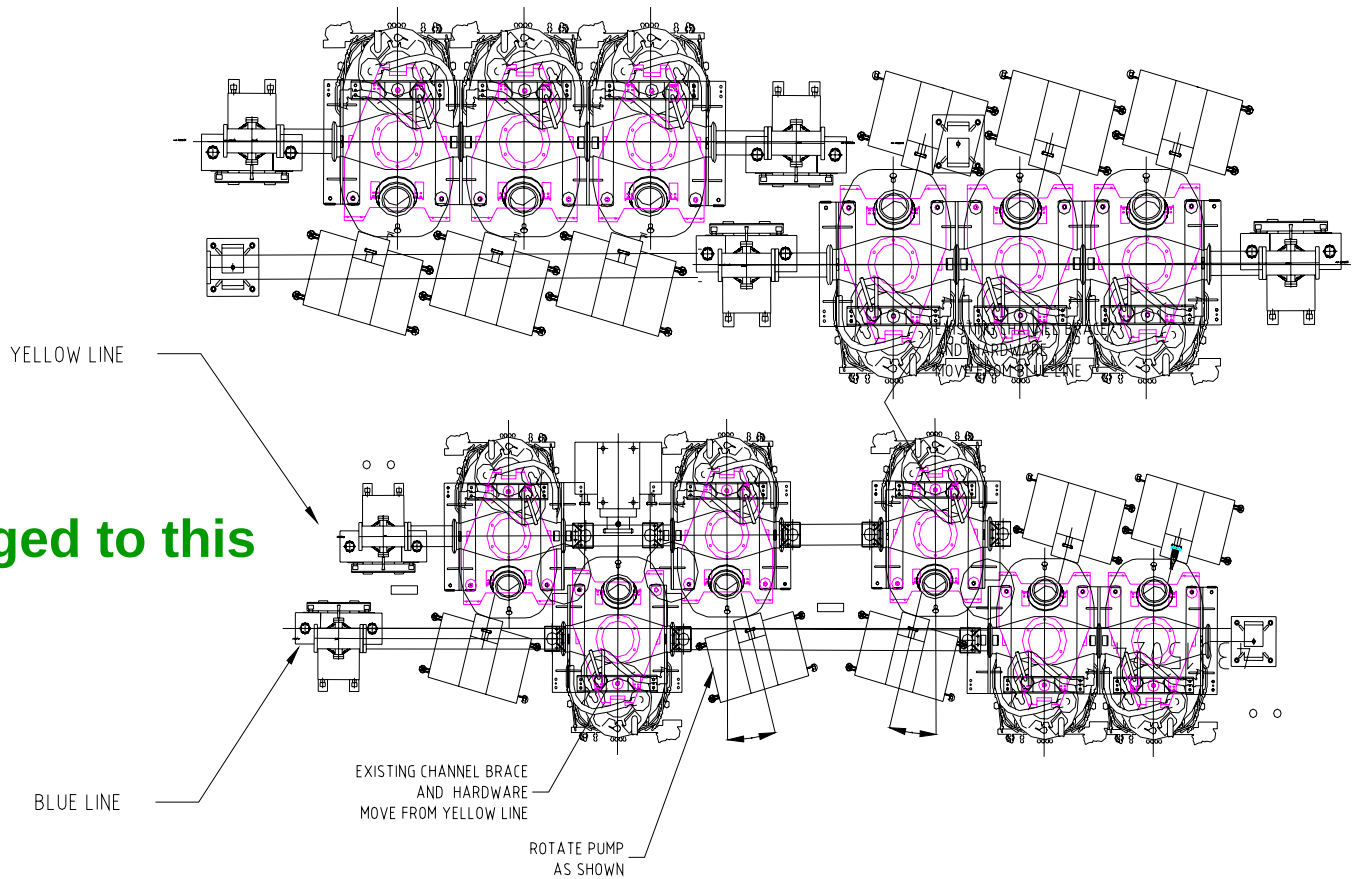


Safety

- The solution is to shuffle the cavities and build scaffolding between them

- **Existing arrangement**

- **Will be changed to this**



Mechanical Tuners on Acceleration Cavities

- They are in constant motion, 24/7
- They follow the ramp (infrequent), and the thermal fluctuations of the cavities (~5 minutes cycle)
- The bearings have become scored and the motion is jerky
- The power amplifiers fight this but the beam still feels phase jumps
- This causes perturbations to the ring-to-ring synchro

Mechanical Tuners on Acceleration Cavities

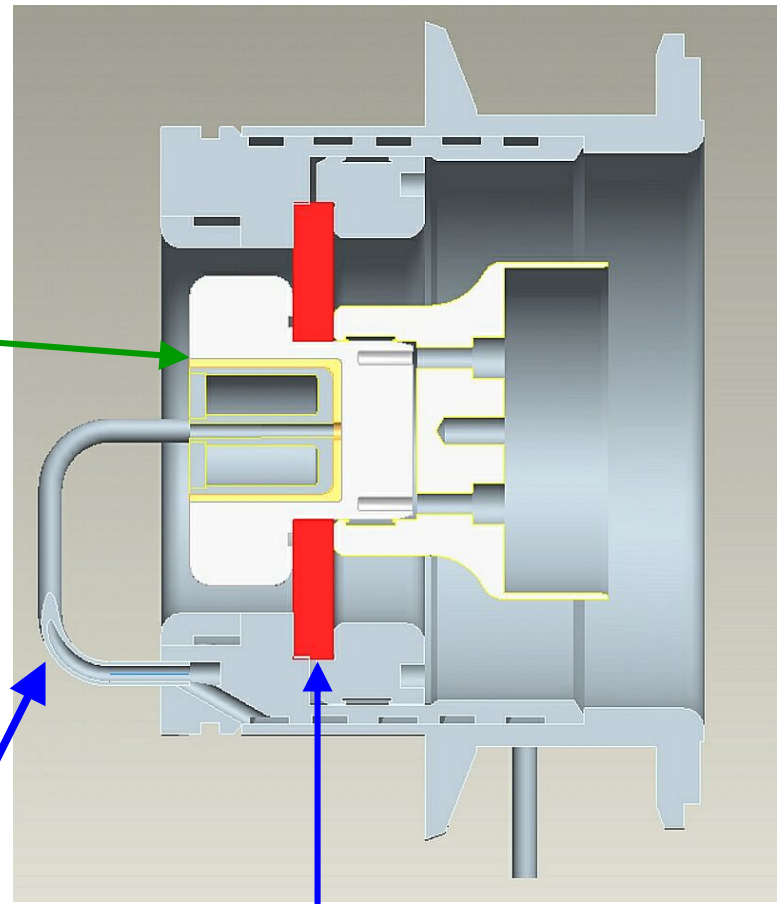
- The bearings will be changed this summer
  - New design (by Steve Bellavia)
  - Necessary to break vacuum
- In parallel, R&D proceeds on a ferrite tuner
  - A limited range vernier tuner will follow the thermal cycles
  - Alex and John Keane are testing some ferrite rings borrowed from FERMILAB booster
  - A commercial firm (AFT) has proposed a design (work in progress)

Storage cavity windows

- The ceramic window on the rf input power coupler are the weak link for achieving full gradient, 6 MV
- This is the first run in which we have not popped a window
- We have tested (fall 04) a new design from CERN that shows promise
- It does not require Ti coating
- It worked great until 500 kV, when it multipactored
  - One-sided multipactor in the coax part
  - The ceramic was not damaged

Storage Cavity Windows

- For the next iteration we will apply DC bias to the coax
  - Bench tests in vacuum of the concept were successful
  - Requires making a "DC blocking capacitor" in vacuum
  - Several techniques have been explored
    - Kapton, baked enamel, flame-sprayed Al_2O_3, anodized aluminum
    - All worked, we'll try anodized aluminum first



Ring-to-ring Synchro at Transition

- For 120 bunches we want to keep the beams in collision throughout the ramp
  - Heretofore we have tried to keep bunches out of collision on the ramp
  - For 120 bunches there will always be “collisions” in the IP common pipe
  - The precision required for maintaining collisions is much greater
    - **Transition is the problem!**
  - To resolve the phase, one must lock the frequency

Ring-to-ring Synchro at Transition

– To resolve the phase, one must lock the frequency

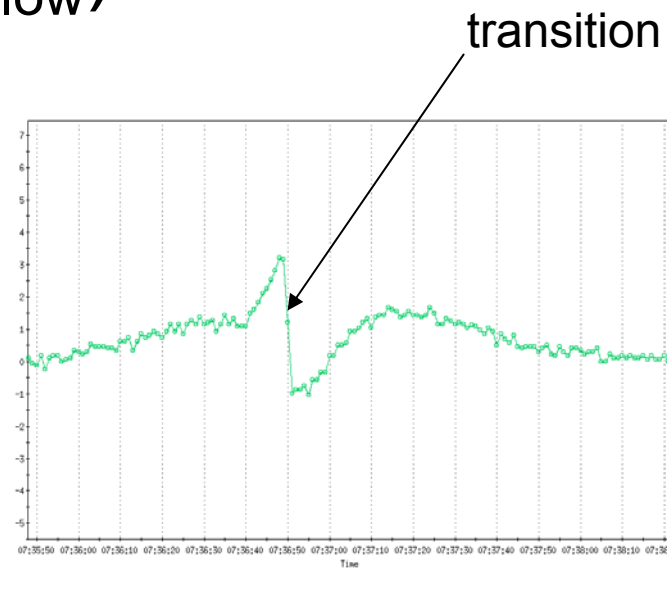
$$\varphi_{\text{blue}-\text{yellow}} = \int (f_{\text{blue}} - f_{\text{yellow}})dt$$

– At transition the tolerance for frequency error goes to zero

$$\frac{dR}{R} = \frac{1}{\gamma_{Tr}^2 - \gamma^2}\left[\gamma^2 \frac{df}{f} - \frac{dB}{B}\right]$$

Ring-to-ring Synchro at Transition

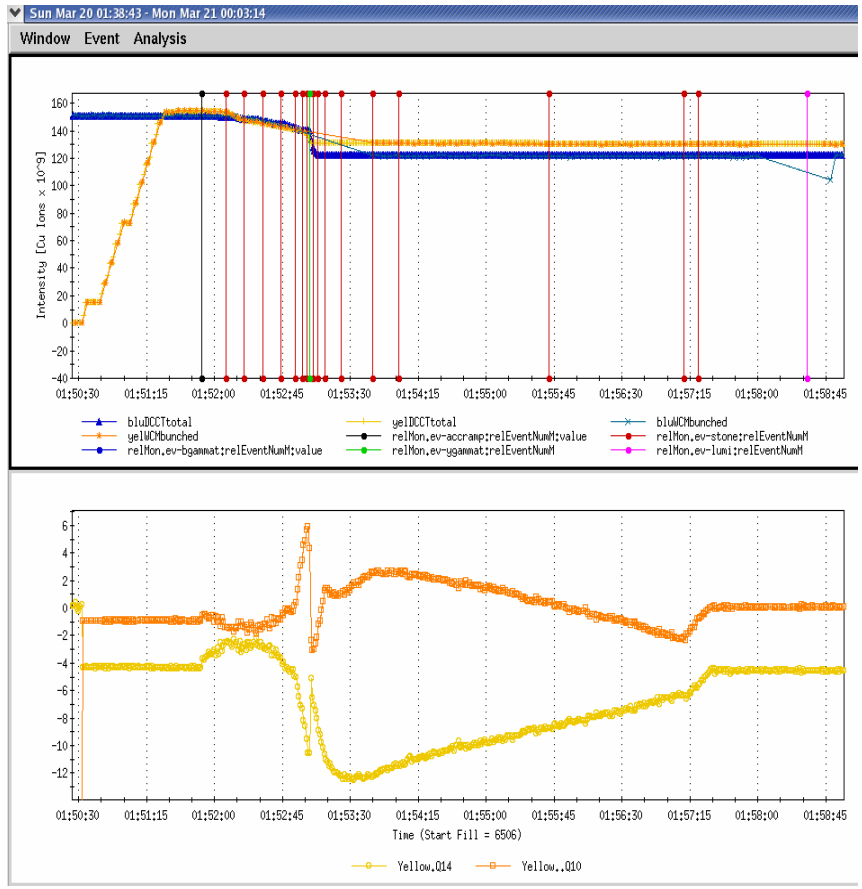
- The concept of the “rubber band synchro” is to enable df/f=0 ($f_{blue} \neq f_{yellow}$) for a few seconds around transition
  - dR/R stays finite
  - The synchro does not get lost (measured at f_{rev})
  - The beam survives!
  - The ramp can be tuned



Phase of yellow vs. blue (buckets)

Ring-to-ring Synchro at Transition

- What does it mean to “tune the ramp”?
  - The rf BPMs only approximate the true mean orbit (rf corrector)
  - The orbit should be centered in the jump quads
  - The real Bρ of yellow has to equal the real Bρ of blue
    - Dipole trims must be tuned
    - Reproducibility of the main magnet current has to be better than ~50 ppm.



Ring-to-ring Synchro at Transition

- For 120-bunch mode we really need x10 better locking. Where will it come from?
  - Tom Hayes has proposed replacing yellow radius signal with the average of both rings
  - Vladimir Litvinenko has proposed servo-ing the dipole field to the radius
  - We could feedforward dipole trim corrections ramp-to-ramp
  - And dynamically program the rf feedback gains around transition.

Summary

- We will undertake a big job to improve safety
- Time has come for the 100,000 mile rebuild of the tuner bearings
- Never say die on the effort to build a bullet-proof window
- The ring-to-ring synchro needs some brainstorms to satisfy the 120 bunch requirement